



Designing a Sustainable, Circular Culinary System

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Abstract

The purpose of this paper is to design a sustainable, culinary system based on the principles of circular economy and systemic design integrating restaurants and hotels of a rural tourism region. The overall research question is: How can the current fruit and vegetable food system be transformed into a sustainable and circular culinary system creating benefits for all stakeholders? As the main aim of this exploratory study is to understand the challenges and experiences of the different actors involved in the current food network rather than measuring flows, the researchers adopt a qualitative approach based on the principles of systemic design. The authors conducted 15 semi-structured interviews with different actors along the value chain in the canton of Valais, Switzerland. The results show that among the factors needed to create a sustainable, circular local food network are a centralized distribution system, efficient transport, better food waste management, sensitization/education of different actors, and better promotion of regional food. The resulting model for a sustainable and circular culinary system includes a regional hub that coordinates the different material and relational flows, the transportation system, and promotional activities including a central marketplace platform. The results are of particular interest for policy strategies focusing on the promotion of regional food networks. In terms of practical applications, the study suggests different solutions to transform current food systems into circular, re-localized food networks that help valorize local food in rural tourism regions.

Keywords Sustainable culinary systems · Systemic design · Circular economy · Food waste · Food tourism

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Introduction

The purpose of this preliminary study is to design a sustainable, culinary system based on the principles of circular economy (CE) and systemic design (SD), employing the case study of the rural region of Valais, Switzerland, where tourism plays a major role in the economy and fruits and vegetables production is important. The research took place in this region as there is still a huge potential to strengthen the links between tourism and agriculture.

The need for sustainable, culinary systems and associated food waste reduction becomes particularly clear when one contrasts the extent of global food waste with the number of people, who continue to suffer from hunger: The share of food waste in relation to global food production amounts to 17%, whereas 9.9% of the world population faced hunger in 2020 [1], not to mention the challenges of loss of agricultural land and of an ever-growing population the world faces today. The objectives of the study are therefore consistent with the United Nations Sustainable Development Goals (SDGs), especially with goals 2 “zero hunger” and 12 “responsible consumption and production” [2].

The study draws on different strands of scientific literature and is embedded in the larger field of food tourism, which has been much discussed in the academic community [3]. In line with several scholars [4], the authors argue that food tourism can be an opportunity for rural tourism destinations to valorize their local produce by creating re-localized food networks. Those networks contribute to sustainable regional development, creating economic, socio-cultural, and environmental benefits. Moreover, food tourism is an answer to current trends, such as tourists’ desire to experience their host country with all their senses to change from their daily connected lives that have become even more virtual and technology-driven in times of the COVID-19 pandemic.

The basis for sustainable food tourism is sustainable culinary systems, as mainly discussed by Gössling and Hall [4] and Roy et al. [5]. As the name of the concept suggests, it integrates a systemic view underlining the need for including “the whole ‘chain’ of human-organized activities concerned with the production, processing, transport, selling, cooking, and eating of food and the disposal of the waste of such activities” [6, p. 664].

Although the scientific literature on sustainable culinary systems is growing, there is a lack of practice-oriented studies focusing on the circularity aspect and valorization potential of food in sustainable culinary systems. The authors argue that the principles of circular economy can help operationalize the concept of a sustainable culinary system [6]. The study of circular economy in tourism is a relatively new field, and most of the studies covering this topic have been published during the last 25 years [7]. Since CE focuses on the manufacturing industry, and more concretely on material and energy flows, the authors additionally draw on the systemic design approach, which includes human needs and relationships [8]. Finally, within the food value chain, this study focuses on the potential of food waste management, to create social, economic, and ecological value. This is a topic of growing interest, especially in the hospitality and management literature [9].

This study addresses the gaps of the literature on sustainable culinary systems by asking the following research question: How can the current food system in the canton of Valais, Switzerland, be transformed into a sustainable and circular culinary system, creating benefits for all stakeholders? Correlated questions are the following:

- What are the criticalities and potentialities of the current food system in the case study region including human needs and relationships?

- How can the current food system be transformed into a sustainable and circular culinary system considering the improvement of food waste management and valorization of food waste?

The paper focuses on the value chain of fruits and vegetables including producers, transformers, hotels, and restaurants, as well as a waste treatment company in the case study region of Valais, Switzerland.

Using systemic design methods, the authors conducted 15 semi-structured interviews with different actors along the value chain, followed by a qualitative analysis of the value chain of fruits and vegetables by identifying potentialities and criticalities. Finally, the authors designed a practice-oriented model for a sustainable and circular culinary system supposed to generate benefits at all three levels of sustainability. Based on this model, the researchers formulated propositions which they plan to test in a future project of applied research.

The remainder of the paper is structured as follows: the “[Literature Review](#)” section focuses on relevant scientific literature around the main concepts that this study draws on. The “[Research Methodology](#)” section presents the research methodology, and “[The Local Food System of Valais](#)” section presents the current local food system of Valais. The “[Findings](#)” section describes the findings, followed by the “[Discussion](#)” section locating them within current scientific discussions. Finally, the “[Conclusion](#)” section draws a conclusion by recapping the findings, addressing the study’s contributions on the practical and conceptual levels, mentioning its limitations, and venturing an outlook into future research topics.

Literature Review

Sustainable Culinary Systems and Local Food Systems

A sustainable culinary system needs to “be able to demonstrate that it can optimize food output and consumption without compromising the stock of natural capital and ecosystem services” [11, p. 12]. Therefore, the aim of a sustainable culinary system is to reduce to the maximum the use of non-renewable resources and to ensure that the use of renewable resources takes into consideration their regeneration capacity. In a sustainable culinary system, waste is reduced to a minimum, and pollution should not outreach the threshold of the regeneration capacity of the system [4]. However, a sustainable culinary system should also be socially just by ensuring food and nutritional security for everybody [10].

The concept of sustainable culinary systems takes a system perspective by considering the whole chain of material flows and human-organized activities along the food value chain including the stages of production, processing and packaging, transport, and distribution (wholesaling and retailing), selling, preparation and cooking (hospitality and food service, such as restaurants, catering, etc.), consuming the product, and finally the disposal of waste. This system perspective illustrates the links between food consumption and supply chains, value chains, and ecological factors [4]. Systems are highly complex, and it is important to bear in mind that a culinary system is a subsystem of the bigger system of society but also of the natural system which has itself reams of subsystems that are interwoven. Threats to one subsystem inevitably concern the other subsystems and finally the whole system’s sustainability [10]. In this view, sustainability can be understood as reaching “a relative equilibrium among social and natural subsystems” [12, p. 252].

The closely related concept of local food systems brings the components of spatial and social proximity into play by referring to “deliberately formed systems that are characterized by a close producer–consumer relationship within a designated place or local area” [4, p. 27]. The geographical dimension requires that an important proportion of food produced in a region is also processed, distributed, sold, and consumed in the same region [11].

Local food systems can engender manifold advantages at the social, economic, and environmental levels for different regional actors and the regional economy [12, 13]. At the socio-cultural level, strong local networks can contribute to community development by strengthening trust and therefore social capital among the different stakeholders, e.g., through a co-operative or the development of local marketing networks, fostering their regional identity, as well as their sense of place, culture, history, and ecology [11–15]. At the environmental level, reduced transport distances together with a more effective and efficient organization of the product volumes transported per load and optimized route planning, as well as the use of environmental-friendly means of transport, lead to a decrease in energy and fuel consumption [12].

To sum up, sustainable culinary systems and local food systems are a well-suited conceptual basis for the implementation of a local food system that meets the criteria of sustainability. However, there is a lack of practice-oriented studies focusing on the circularity aspect of a sustainable culinary system, in general, and the valorization potential of food waste.

This study employs a product-oriented view concentrating on the fruit and vegetable value chain. The research includes commercial organizations, more concretely hotels and restaurants, not however cost-driven institutional organizations [15], as there is a huge potential in the case study region to improve this part of the system. Nevertheless, several findings might also be interesting for non-commercial organizations, as they are part of the system, and the creation of synergies could be interesting. In order not to go beyond the scope of the project, further elements, such as inputs to farming including machinery, chemicals, seeds, and water, or external elements like regulations, the financial systems, or laws are not taken into consideration, although they can have an important influence on the sustainability of a product (e.g., chemicals) or the implementation of solutions of food waste valorization (e.g., regulations and laws).

Circular Economy and Valorisation of Food Waste

Scholars and practitioners alike acknowledge the potential of the concept of circular economy (CE) to operationalize the principles of sustainable development [16]. CE offers an alternative to the current linear and unsustainable economic model based on the “take, make, use, dispose” system [17, 18] by suggesting a circular and “regenerative system in which resource input and waste, emission and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling” [20, p. 759].

Jurgilevich et al. [21, p. 2] argue that “circular economy regarding the food system implies reducing the amount of waste generated in the food system, reuse of food, utilization of by-products and food waste, and nutrient recycling.” They emphasize that “the measure must be implemented both at the producer and consumer levels, and finally in the food waste and surplus management” [21, p. 3]. Borrello et al. [19] outline the importance of transforming “waste into higher value products by making them the input for other

products” [22, p. 2]. It is about reducing “value destruction in the overall system and [maximizing] value creation in each link in the system” [22, p. ix].

Food waste represents an important part of the waste generated in the hospitality sector with considerable financial implications. In Swiss gastronomy, for example, an estimated 208,416 t of food losses were calculated for 2017 [20]. In the UK, the hospitality sector created about 3 Mt of food waste in 2011 and the overall cost of food waste reached £3 billion in 2016 [21]. Food waste negatively affects climate and biodiversity and is highest regarding bread and bakery products (particularly milling losses), cheese (especially whey), beef (edible parts with low demand), and fresh vegetables (particularly household waste) [22].

Beretta et al. [22] underline that to improve food waste management, it is indispensable to include the whole value chain and its different actors. A major problem is consumers’ expectations, such as aesthetics of the products or variety and availability. Betz et al. [23] list different measures for food waste reduction according to the stage including better management, analysis of sold meals, conservation techniques, adaption of portion size, and sensitisation measures for the customers.

In a nutshell, it is of utmost importance to “minimize value destruction in the overall system and to maximize value creation in each link in the system” [23, p. ix]. There is huge potential to achieve benefits for most of the actors involved by better food waste management, as food waste is not only an ecological but also an “economic and social problem” [8].

Systemic Design

As CE mainly focuses on the manufacturing industry, and more concretely on material and energy flows, the authors draw on the systemic design (SD) approach. Systemic design (SD) deals with wicked, systemic problems by delivering systemic solutions [7]. Its main goal is to initiate a paradigm shift by (1) changing the management of resources and promoting a continuous transformation of matter and at the same time (2) activating new relationships between actors that generate wellness improvement [8].

Hence, SD combines the management of material and energy flows with the activation and strengthening of relations between different actors. SD is a methodology that combines system thinking with practical methods of design thinking. The SD approach can be understood as “a design-based approach that outlines and plans the flow of matter running from one system to the others, pursuing a metabolization process, which should reduce the ecological footprint and generate profitable economic flows” [24].

According to Bistagnino [25], systemic design is based on five principles:

- (1) Output becomes input: The waste of one system becomes a resource for another one “to generate a continuous flow of material, energy, and information, generating the strengths of the system itself” [27, p. 288].
- (2) Relations generate the system: The different elements of a system interact by exchanging energy, material, and information. The quality and efficient organization of those flows represent the strength of the system. Rural areas and tourism destinations, however, often lack strong and resilient networks, which makes them very fragile [24].
- (3) The system is self-generating: Like their biological models, they are self-regulating and co-evolve dynamically with other systems as a whole and keep their stability. However, in rural areas and tourism destinations, the flexibility to adapt to a changing environment is often lacking [26].

- (4) Actions are local: To act at a local scale and to value local human, cultural, and material resources is a priority.
- (5) Human beings and their needs are central: Human beings and their needs stand at the center of the project. They are embedded in their environmental, cultural, social, and ethical context [8].

This study draws on a combination of the different concepts presented above to serve as a conceptual framework (see Fig. 1). The basis is the concept of sustainable culinary systems in the context of food tourism as mainly developed by [5, 6, 10]. This literature, however, lacks in-depth elaboration of circularity and valorization aspects. That is what the concept of the circular economy provides [27]. Moreover, the circular economy concept is meant to help operationalize sustainability. Furthermore, systemic design has the advantage of being practice-oriented and not only concentrating on material flows, but also on the activation of relationships between different actors [8, 24, 28]. For this reason, the study takes up several aspects of this methodology (see below). Finally, the study draws on food waste literature that underlines the potential of avoidable food waste valorization [9, 20, 23].

Research Methodology

As one of the main aims of this exploratory study is to understand the challenges and experiences of the different actors involved in the current food network rather than measuring flows [29], the researchers adopt a qualitative approach including the following steps:

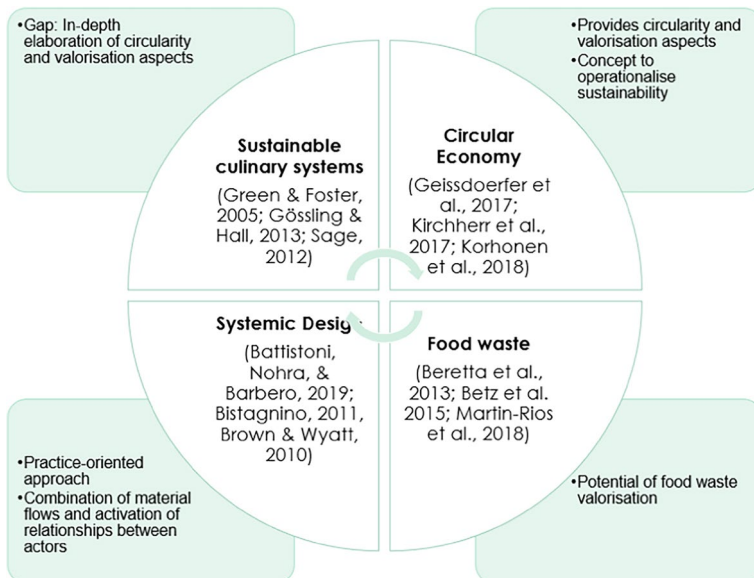


Fig. 1 Conceptual framework. Source: own elaboration

- (1) Identification of the challenges, needs, and experiences of the different stakeholders involved in the current food network
- (2) Suggestion of a model for a sustainable and circular culinary system
- (3) Formulation of propositions

This method is inspired by systemic design methodology that has been elaborated by a research group at the Politecnico di Torino consisting of the following 6 steps: (1) holistic diagnosis, (2) identification of potentialities and criticalities, (3) design of a new system, (4) analysis of possible results, (5) implementation, and (6) analysis of outcomes and feedbacks [8]. The study concentrates on steps 2 and 3, not however without considering the context of the current culinary system based on insights from (informal) discussions and immersions including cantonal and national public authorities, but also restaurants and the representatives of the associations of the different stakeholders, such as the fruit and vegetable association of Valais or the cantonal Restaurant Association and Hotel Association. To identify the criticalities and potentialities, as well as the experiences and needs of the different stakeholders along the value chain, the researchers employed a purposeful sampling strategy [30], conducting semi-structured interviews with different actors (farmers, transformers, caterers, hotel keepers, and the manager of a waste treatment company) along the value chain of fruits and vegetables in the canton of Valais, Switzerland. The authors chose a purely qualitative approach, as they concentrate in the first step on qualitative aspects of ecological, social, and economic potentialities and criticalities to deeply understand the phenomenon rather than on measurement. The propositions formulated at the end of the discussion part serve as a starting point for a more quantitative follow-up study. The project partners were at the same time representatives of the different actors and helped choose suitable interview partners taking into consideration the variety of backgrounds (e.g., standard restaurants and luxury hotels) and geography/culture (in the German-speaking and French-speaking part of the canton). Most of the interviewees are already practicing valorization of food waste and dispose therefore of valuable knowledge regarding economic, social, and ecological potentialities and criticalities. In general, they are best practice examples with an entrepreneurial behavior having a leading position within the system. After 15 interviews, data saturation was reached. The interview questions focus on the different actors' challenges regarding the treatment of food waste and their relations with the other actors in the food system, as well as on existing solution strategies.

To support the findings, the authors use power quotes. The abbreviation IV stands for interviewee followed by a random number to reference the interviews. The quotes were translated from French and German into English.

The Local Food System of Valais

The canton of Valais is an important producer of vegetables and especially fruits in Switzerland. Two hundred twenty-five farmers cultivate vegetables in an area of 260 ha and fruits in an area of 2182 ha. They produced 8 million kg of vegetables and 52 million kg of fruits in 2019. The gross yield of the vegetable sector accounts for CHF 15.5 million, the gross yield of the fruits sector for CHF 70 million in 2019. The gross yield of 2019 corresponded to the 10-year average. Table 1 focuses on fruit production, as the canton of Valais produces and sells roughly one-third of Swiss fruits and 100% of Swiss apricots. It shows the absolute and relative production area compared to the entire Swiss production area, the production volume, and its difference compared to the previous year.

Despite the rich agricultural heritage, there is potential to augment the part of local fruits and vegetables in hotels and restaurants in tourist destinations in Valais.

Findings

Primary Food Production

One of the principal criticalities at the production stage mentioned by the interviewees is a divergence between offer and demand regarding quantity and seasonality, as this quote underlines: “The market is such that the demand often doesn’t match the offer” (IV12). Another interviewee outlines the problem of seasonality: “As we don’t deliver throughout the season, people don’t want to buy from us” (IV15). IV14 underlines: “Obviously, there’s an alternation. There’s a year with a lot of production and a year with little production” (IV14).

Then, there is a lack of coordination in the production of different types of fruits and vegetables, especially regarding more exotic fruits such as melons. There seems to be a need to specialize and to exchange products among producers to sell them via direct marketing (IV15). Additionally, there is a lack of overview of installations (e.g., for food processing) and investment plans for machines and installations among the farmers as this quote underlines: “It would really be necessary for one of us to invest to make dried fruit for everyone [...]. It would be good to work together” (IV15). This would foster economies by preventing each farm from buying its own machine. Moreover, a well-functioning network between producers and actors in the processing industry seems to be lacking: “Relationships are often missing. The producer [...] has other problems and he doesn’t always have the idea of eventually adding value to his products” (IV12).

Table 1 Production area, production volume, and difference in production volume of fruits compared to the previous year in Valais 2019

Fruits	Production area in hectares Valais	Percentage of Swiss production area	Production volume in tons in 2019	Difference regarding 2018 in %
Apples	1033	27.3%	32,485	- 11.69
Pears	314	41.0%	8627	- 2.88
Apricots	708	95.4%	8492	- 4.05
Cherries	27	4.5%	140	- 2.78
Prunes	33	10.4%	905	- 17.35
Strawberries	43	8.4%	711	6.92
Raspberries	15	8.8%	138	2.99
Berries	4	2.1%	46	9.52
Table grapes	3	16.7%	12	9.09
Peaches	1	9.1%	NA	NA
Quinces	1	9.1%	NA	NA
Divers/kiwi	0	0.0%	NA	NA
Total	2182	30.4%	51 556	- 8.93

Source: Valais Fruit and Vegetables Interprofession (2020) [32]

Concerning food waste, overproduction, fruits and vegetables that do not meet sales or aesthetic standards, and fruits and vegetables hanging on trees or being left in the field are the main challenges, as these quotes outline:

“And this year we have tons of apricots that went to the compost in Valais” (IV11).

That’s the idea, to be able to recover merchandise that is not waste but that can’t be sold, because it doesn’t look good enough, there are too many, the season is over, nobody wants it anymore, etc., and to find a solution to be able to reuse it and give value to this merchandise (IV12).

The products stemming from overproduction or being deformed or of 2nd choice are perfectly edible, meaning that they are part of avoidable losses [22, 28]. Yet, it is difficult to prevent overproduction and the existence of products that do not correspond to common aesthetic ideals as this depends on many factors such as the weather, demand, and people’s tastes.

Among the potentialities regarding the valorization of fruits and vegetables stemming from overproduction or not corresponding to norms is their transformation into products that take different forms, such as jams, sauces, purées, chutneys, dry fruits and vegetables, fruit bars, juices, and liqueurs and their sale via a farm shop as interviewees underline (IV13, IV14, IV15). Another interviewee mentions the collaboration with an admission center for adults with difficulty or a center for people with disabilities who transform fruits and vegetables into canned courgettes, or, e.g., onions (IV10).

Fruits and vegetables, however, that are left in fields or hanging on trees are more difficult to valorize: Several interviewees underline that it is simply not profitable to pick them (IV11, IV14). Some producers propose a self-service for the population (IV15).

Table 2 gives an overview of the criticalities and potentialities identified along the value chain of fruits and vegetables.

Food Processing

During the food processing stage, food waste can occur in the form of pulp, fibers, or pits and seeds (IV12, IV14). Sometimes even first-quality fruits are processed, which implicates a loss of value (IV12).

Among the main potentialities are the transformation of food waste into value-added products. In this context, a valorization of pits from the Luizet apricot, which is a typical apricot variety in Valais, in cosmetics, pharmacy, or nutrition would be especially interesting [31]. The health aspect of much of the (possibly) avoidable food losses is particularly interesting. For instance, an interviewee who runs a restaurant and a bakery transforms the grape seeds of a local winemaker into different products, such as flour, bread, pastries, and cosmetics. Then, the winemaker serves the local baker’s pastries during wine-tasting sessions to his visitors (IV9). Both apricot kernels and grape seeds have specific positive effects on human health that have been partly forgotten or that at least have not been valorized, e.g., in the context of tourism.

During the production of fruit juice, pulp and fiber are generated. These could be resources for other value-added products, such as fruit bars (IV14). The owner of a processing factory said that most of the waste produced went directly to the biogas factory, as it would not be profitable, for instance, to dry the apricots, as he does not have enough to make the facilities profitable (IV14). This example shows that there is a paradox in rural

Table 2 Criticalities and potentialities along the value chain of fruits and vegetables

Fruit & vegetable value chain		Production	Processing	Sales	Purchase	Preparation & consumption	Disposal & recycling of food waste
Ecological criticalities: food waste	- Overproduction (no possibility to conserve everything)	- Pulp, fiber, apricot pits	- Returns from wholesalers as the products do not meet expectations				
	- Damaged / non-compliant fruits and vegetables, 2nd choice fruits and vegetables hanging on the trees or left in the fields	- Pulp goes directly to biogas factory					
Potentialities: possible solutions for food waste	- Transformation of overproduction and non-compliant fruits and vegetables and sale in farm shops	- Transformation of leftovers into products with added value: e.g. utilization of apricot pits or grape seeds for cosmetics, nutrition, pharmaceuticals (health aspect of apricot pits)	- Processing (jams, sauces, etc.)				
	- Self-service harvest for local population and tourists						

Table 2 (continued)

Fruit & vegetable value chain

	Production	Processing	Sales	Purchase	Preparation & consumption	Disposal & recycling of food waste
Social and economic criticalities	<ul style="list-style-type: none"> - Lack of coordination of production - Lack of overview of installations (machines etc.) among farmers - Missing links between producers and transformers - Divergence between offer and demand (quantity, quality, seasonality) 	<ul style="list-style-type: none"> - Processing of first-quality products (loss of value) - Transformation not profitable, as not enough quantities 	<ul style="list-style-type: none"> - Price fluctuations of prices - Lack of price strategy - High dependence on wholesalers - Lack of knowledge of the market - Lack of communication, market development - Lack of knowledge regarding online sales - Lack of contact with restaurants - Changes in availability of products - Lack of transportation possibilities to clients - Lack of knowledge concerning beneficial effects of local, seasonal food, of organic food 	<ul style="list-style-type: none"> - Higher prices for regional food - Limited relations to producers - Lack of centralization of the offer - Divergence between offer and demand: Assortment too limited (variety of products, seasonality) - Lack of professionalism regarding billing - Lack of ready-to-cook products - Inefficient transport system 	<ul style="list-style-type: none"> - Lack of time to prepare non-compliant food - Lack of assistant chefs - Lack of knowledge/sensitization of team at restaurants/hotels: Regarding preparation of regional food / non-compliant food / regarding valorization, transformation, storage of food - Restaurant clients: Regarding price, work that is needed to produce regional food - Lack of communication regarding regional food 	<ul style="list-style-type: none"> - Restaurants: Costs for restaurants to dispose of waste - Waste treatment plant: - Costs for transport of food waste from restaurants - Need of good quality waste - Currently low quantities of agricultural waste

Table 2 (continued)

Fruit & vegetable value chain

Production	Processing	Sales	Purchase	Preparation & consumption	Disposal & recycling of food waste
Potentialities: Possible solutions - Specialization - Better coordination, and collaboration - Collaboration to achieve sufficient quantities	- Better management of sales - Collaboration to achieve sufficient quantities	- Sales via online platforms/ direct marketing to increase margins - Farmers determine themselves their prices - Training of producers concerning online sales - Synergies with existing transport companies - Direct communication with customers	- Higher prices for local dishes (e.g., in luxury hotels) - Relations with local producers based on trust - Specials of the day with different price categories - Specials of the day adapted to seasonality and availability - Different price categories for lunch and dinner - Communication regarding origin of food, freshness, and other labels, such as organic - Savings thanks to food waste management - Producers who offer already peeled asparagus - Synergies with existing transport companies	- Better training and sensitization of teams at hotels/restaurants - Better communication and sensitization of restaurant clients	- Production of biogas and compost - Sensitization of customers to sort waste

Source: own elaboration

regions that they do not have enough food waste for their machines to be profitable. Therefore, it costs less to dispose of the waste.

Food Distribution and Transport

Sales

When it comes to the sale of fruits and vegetables, one of the most important economic challenges concerns the price. Some producers say that restaurant and hotel keepers often want to pay low prices, have high-quality expectations, and often only want to buy small amounts of the different products:

“Restaurant keepers are very complicated for traders because they are always slashing prices” (IV10).

On the other hand, restaurants are very demanding regarding availability, quality, and quantity, which poses a challenge for producers.

A solution could be that restaurants and hotels adapt their menus and daily specials/suggestions (IV6, IV7) according to the availability of products and seasonality.

Additionally, fluctuating market prices pose a challenge for farmers. Most of them do not dispose of a pricing strategy, as one interviewee outlines: “A lot of training is needed to make better pricing strategies” (IV10). Neither do they have the necessary knowledge to sell their goods online (IV10), although this could be a solution to get better prices and coordination.

Additionally, logistics and transport seem to be a problem, as a central transportation system is lacking. The topography of the region that consists of a main valley and several lateral valleys with remote tourism destinations makes transport even more difficult. The following quote summarizes the problem: “Well, we’d like to work more with restaurant owners. Yet, the problem we have is that we don’t do deliveries” (IV15).

However, some interviewees have found solutions to deal with these challenges. For instance, one interviewee collaborates with a butchery supplier who delivers meat and fruits and vegetables to the lateral valleys at the same time. However, this is not always easy as different products are subject to different legal transport requirements (IV14).

Another challenge, some producers perceive, is a lack of knowledge concerning the benefits of organic production among restaurant and hotel keepers/cooks, the health effects of the different aliments, and the work that is behind the production of fruit and vegetables (IV13, IV14). Hence, it seems to be important to strengthen the links between producers and consumers and to sensitize and educate restaurant and hotel keepers/cooks, as well as customers.

As to food waste, several interviewees mentioned the dependence on big supermarkets as a challenge: “They decide everything, the price and whether they take [the products] or not” (IV15). In the context of local food networks, it is preferential to keep the number of intermediaries as low as possible and to favor direct marketing. However, there are some restaurant and hotel keepers/cooks that prefer to go to the supermarket, as there they can find everything they need in one place (IV4).

A further challenge concerns some farmers’ lack of market knowledge and related to that insufficient communication measures (IV14).

Another challenge related to food waste is the returns of goods that do not correspond to the expectations of wholesalers (IV15). As those goods are perishable, there is a very short time window for selling them if they are not transformed or sold immediately.

Purchase

The price is also one of the main concerns of restaurant and hotel keepers at the purchase stage. They often perceive or identify a significant price difference between regional and wholesale products that are often from outside the region. Some interviewees illustrate the price differences:

If I take the example of the asparagus grown in Valais, we pay almost 13 francs per kilo, and when we go to [a wholesaler] for example, asparagus from Peru costs 8.90 francs per kilo (IV1).

The restaurants which already offer local products point out different ways to deal with the price problem. One way is to sell meals at higher prices. This seems to work in high-end restaurants and hotels, whose clients are already sensitized and appreciate the quality of local products, as the manager of a five-star hotel in a well-known tourism destination underlines: “You can ask the customer to pay a higher price, so you can also buy organic products, because the customer is willing to pay for the higher quality” (IV3). The same hotel manager also says that it is part of their philosophy and that they can do this as they are “willing to lose some margin, because we want that” (IV3). This shows that it also has to do with the commitment and conviction of restaurant keepers to support the local food producers.

Another interviewee says “I want these regional products of high quality; therefore, I have to ask for a higher price” (IV5). Quality seems to be an important argument for offering local products. Other arguments are positioning, strengthening of identity, and social and environmental responsibility:

“I think it gives the establishment an identity because it’s a positioning. And I think it is also a social, environmental, regional responsibility, to do something to change people’s thoughts” (IV3).

A restaurant keeper who has a clientele with a limited budget says:

We tried it, we increased prices, you can have lunch here as much as you want [...] and it costs 18 francs altogether. Before, it cost 15 francs and then we went up and we lost about 30% of the clientele and didn’t earn more. 18 is the threshold of pain (IV2).

The same interviewee underlines that there is a difference between lunch and evening meals: “In the evening you can make a higher price, at noon it’s different” (IV2).

Restaurants that serve clients, such as laborers who come every day, are not able to increase prices, due to the limited budget of their clientele and sometimes a lack of sensitization concerning the consumption of local products (IV2).

There are several potential solutions for dealing with these challenges. For instance, a restaurant keeper who is a model concerning the management of energy and food waste says “I can afford the price, because I have so little waste and also thanks to electricity [...] because it is not possible to charge the client” (IV2). This example shows that the reduction of waste and the savings for energy as the restaurant is heated by solar power can outweigh the higher prices. Another chef suggests specials of the day with different price categories to address different customer segments: “And I change the price, my price is between 18 and 26 CHF. The idea is to have something noble at 26 francs” (IV4).

Moreover, different interviewees mention access to different products as a challenge. The most important sticking points are the lack of centralization of the offer, as these power quotes illustrate:

I cannot go anywhere; I cannot go from Conthey to St. Léonard or Ardon or further to Martigny [names of towns in Valais] to buy only zucchini. It's very difficult, even though I know the products there are of great quality (IV4).

The restaurant keepers also mention the challenge regarding the divergence of offer and demand. One of them explains a potential way to deal with the problem of seasonality:

“You can make very good dishes with the same vegetable” (IV6). He communicates that his dishes are fresh and regional, and people appreciate this. So specials of the day can be adapted to availability and seasonality (IV6). One interviewee underlines that he is very proud of communicating to his clients: “Yes, I mark here that I use fresh produce always, I mark the origin of the vegetables. I also mark that it comes from the biosuisse [a Swiss organic label] culture. I am proud to mark this” (IV4).

The challenge of seasonality is mainly related to the clients' wishes. One interviewee says “The client is asking for this. [...] two thirds of Greek salad consist of tomatoes. I sell more in January, February, March than all summer. Because people are looking for the sun, they move around, they say we're going to spend a moment in Greece, and we'll eat a Greek salad” (IV4).

He adds that it is not easy to sensitize the clients regarding seasonality: “It's very difficult. It's not a selling strategy” (IV4).

As to the relational aspect of the purchase stage, some interviewees say that the personal relations to the producers are limited, which is mainly related to a lack of time on both sides: “The ordinary cook does not have time to look at the products, to visit the farmers” (IV2). One interviewee who is relatively new to the restaurant business says that “it is difficult to create a network [with the farmers]” (IV7).

Another interviewee explains that word of mouth plays an important role to find good partners (IV6). Trust seems to play an important role for restaurants, too, as this statement shows: “But instead of ordering, they just get it from the farmer they trust” (IV5). One interviewee suggests organizing festivals to bring together farmers and restaurant keepers (IV6).

The lack of ready-to-cook products mainly concerns cooks who work in collective restaurants, such as hospitals, canteens, or nursery schools. As those establishments are very much under time pressure, it is crucial for them to have preprepared products at their disposal (IV10). Nevertheless, even a cook who loves to work with vegetables says: “The problem is that at some point we can't keep up. If you must peel 20 kg of asparagus at some point you have to accept it. You take the easy way out; you pay a bit more” (IV6).

One interviewee at a luxury hotel points out that there is a lack of professionalism in dealing with the bills:

In a company like ours, which is a public limited company with a turnover of more than one million, we have audits, we are obliged to have invoices that are a little more serious than bits of paper (IV8).

To sum up, the price seems to be a problem for both producers and restaurants. Among restaurants' needs are a centralisation of the offer and stronger personal relations with producers. Some of them would like to have access to ready-to-cook products and wish for more professionalism, e.g., when dealing with bills.

In general, there is a need for better management of the transport system (IV3, IV8, IV9). To solve this problem, one restaurant, e.g., asked the beverage supplier to transport regional products, too (IV9).

Food Preparation and Consumption

Among the challenges at the food preparation and consumption stage is a lack of knowledge and/or time regarding the preparation of (regional) food, non-compliant food, and the valorization, transformation, conservation, and storage of food. The following quotes emphasize some of those aspects:

In 30 years, the world has changed, and the recipes: When they tell them how to cook a carrot, it is scary: They use 4 L of water to cook a carrot, so the nutrients, the ecology, the taste, everything is lost, that's it. So, there's the training that I think is important (IV8).

For example, the Flat Iron Steak, you have to know this as a cook. Many people turn it into boiled meat. But if you prepare it properly, it tastes very good (IV5).

For example, offering a Flat Iron Steak is at the same time a solution to lower the price compared to a tenderloin. Several interviewees identified a need to sensitize restaurant clients regarding the price of regional food, the work that is needed to produce regional food, and the problem of food waste in general. Often, clients are only interested in the best parts of meat, as one interviewee underlines: "The client wants a steak, an *entrecôte*" (IV4).

Another challenge identified is that communication measures regarding regional food are not strong enough (IV9).

When it comes to food waste, most of it seems to be generated when peeling fruits and vegetables and handling fresh products:

We have a lot of food waste, especially regarding fresh food. With some of it we try to make soup. But in the summer, we can't make them, and we can't put everything in these soups. We even try to make sauces. But when we start working with fresh products, we know that we're going to increase the amount of waste (IV6).

Large amounts of waste seem to be produced during the breakfast buffet (plate waste). One restaurant keeper states: "In the morning at breakfast, there are people who make plates this big and then only eat the ham and the croissant, the rest goes into the garbage" (IV1).

There are many ways to deal with food waste during the preparation and consumption stage, including better planning of purchases, daily delivery of fresh food by ordering only what the cook really needs, or valorization of food waste through transformation (see Table 1). For example, cooks can make a bouillon with peelings or not peel vegetables at all by only brushing a carrot instead. One interviewee showed the authors how he passes several stages of food preparation to avoid food waste, by freezing courgettes, making a courgette steak, and finally a chutney (IV4). To be able to use different vegetables, some restaurant keepers never give a detailed description of the side dishes on the menu (IV2, IV4). Other solutions to deal with food waste are doggy bags or donations to people in need (IV2, IV3, IV9). Surpluses can also serve as the ingredients for the employees' meal (IV3). The nose-to-tail approach, meaning to purchase the whole animal by using as much of it as possible [15], is difficult to implement, as many customers are not sensitized in this respect and prefer to eat only the "best" parts of the animal. Some customers of the luxury segment seem to be sensitized in this regard (IV3).

Disposal and Recycling of Food Waste

As to the disposal and recycling stage, a restaurant keeper says that he has some legal problems concerning his waste management: “We must pay to get rid of the waste now, even if there was a lady who took our waste to feed her animals. Now, she must pay to buy food for her animals” (IV1). Another restaurant keeper and cook mentions the high waste disposal costs (IV7). However, these could be reduced through better food waste management.

The most important challenges identified by the person in charge of the methanation plant are transport costs to collect food waste. This explains why it is currently not possible to collect food waste for free, as the volumes would have to be much larger to cover the costs for biogas generation. The effort to process and condition the waste is considerable, which customers do not necessarily realize. There is a need for more training for restaurant/hotel owners and the public on this subject.

Sensitization measures for the public are also important concerning the waste quality, which must be high for anaerobic digestion plants: “If we have high quality waste, we will be able to do more valorisation, more gas, and therefore sell much larger volumes” (IV16).

This means that food waste must not be mixed with other materials, such as plastic. According to the plant manager, accessing the bin with a card helps achieve good quality of waste during tests with private households in Sierre (city in the canton of Valais), as people feel more watched.

As far as agricultural waste is concerned, no large quantities are currently taken to the plant. It would be necessary to know the volumes and the work required to collect more waste from agriculture, as the aim is to put the cleanest possible material into the digester.

At the end of the cycle, gas can be extracted from digested foodstuffs, and finally, compost can be produced. This procedure makes it possible to extract methane, which is a greenhouse gas, to produce biogas in the first instance and then to create compost.

Discussion

The main challenges of the food system in Valais are in line with other scientific studies and include (1) a lack of centralized distribution and an efficient transport system. According to Green and Dougherty [3939] and Nilsson [2016], logistics is a major problem in local food networks, particularly regarding efficient management, volumes and distances. Delivery costs are high, especially when the ordered volumes are small, and restaurants are located far from the centers [32]. Another challenge is (2) the differences in price perception between producers and buyers [13]. While producers often think that they are not sufficiently remunerated for their efforts, restaurants and hotels only have small margins. Moreover, there exists (3) a divergence between offer and demand regarding diversity, quality, quantity, and seasonality of food [12, 30, 32]. This is linked to restaurants' supply chain management and their primary concern for product availability and consistency, quality, and pricing [15, 33]. Furthermore, the authors identified (4) a lack of knowledge of and sensitization to the benefits of regional and seasonal food especially among the population and (5) a lack of knowledge regarding the preparation of regional food and food waste management. Nilsson [12] highlights that the added value of preparing dishes with local food is often unclear for restaurants, and their margins are very small. Better knowledge about local food, growing

season and cooking have the potential to improve the problem of mismatch between offer and demand [14]. The (6) lack of knowledge and sensitization is strongly linked to the lack of promotion of regional food. Roy et al. [5] investigated the barriers regarding the use of local food in the hospitality sector in Vancouver, Canada. Their findings show that many of the identified challenges could be managed through improved communication and supply channels. Moreover, communication regarding the availability of products, health aspects of local food, and ecological benefits seems to be pivotal for the establishment and the successful maintenance of a local food system. Several rural regions are, however, confronted with a limited marketing budget, which makes it difficult to achieve this goal [10]. Finally, the relations between producers, transformers, and restaurants/hotels could be strengthened. Buck et al. [11] emphasize that the potential spatial fragmentation of producers, distributors, and consumers is among the main challenges for local food networks to become a reality. Knowledge transfer and information flows between producers and restaurants, as well as trust, seem to be two further key ingredients of well-functioning local food networks. The development of trust-based relations and reputation is essential for producers to get access to the market. However, existing communities of trust can also prevent the participation of new entrants. To guarantee information flows in an often-fragmented value chain, farmers and restaurants can organize meetings at farms or restaurants or meet at events [34].

At the organizational level, especially for regions with many small to mid-sized farms, it could be advisable to establish a food hub to coordinate and organize the different activities of “aggregation, distribution, and marketing of source-identified food products primarily from local and regional producers to strengthen their ability to satisfy wholesale, retail, and institutional demand” [37, p. 4]. Regional food hubs address the needs of such farms by actively coordinating supply chain logistics. Although a food hub can support farmers by selling products to wholesalers, retailers, and institutions, the authors argue that it can also play an important role in farmer-to-restaurant sales. A business management team builds the core of a regional food hub. The hub’s pooling of regional produce from different farmers helps to meet the demand regarding the quality and availability of products. Food hubs themselves can invest in distribution infrastructure or collaborate with partners along the supply chain being situated at the heart of a value chain [35].

Based on insights from the interviews and scientific literature, the authors designed a model of a sustainable and circular culinary system (see Fig. 2). One of the most important elements of this model is the regional coordination hub that improves coordination between different stakeholders, suggests trainings and coachings, e.g., in terms of pricing strategies, oversees logistics and the promotion of regional products, and organizes events to bring the different actors together.

Other important aspects of the model are the centralized virtual and/or physical market platform and better management of transport by calculating volumes and trajectories and by ideally delivering products with vehicles that use renewable energy [12]. Moreover, it could be beneficial at the ecological, economic, and social levels to work with existing delivery companies that still have some space for other products. Through economies of scale, by centralizing the offer and optimizing the transport system, prices could probably be lowered. Another solution would be to suggest different prices regarding the product categories: Restaurants can buy damaged, non-compliant, second-choice fruits and vegetables, or food returns from wholesalers for a lower price and use them for purée, cakes, etc. These fruits can also be directly transformed into value-added products like liqueurs or sauces, e.g., with the help of a reception center for adults with difficulty or a center for people with disabilities. Those products could be sold to tourists and restaurants or hotels.

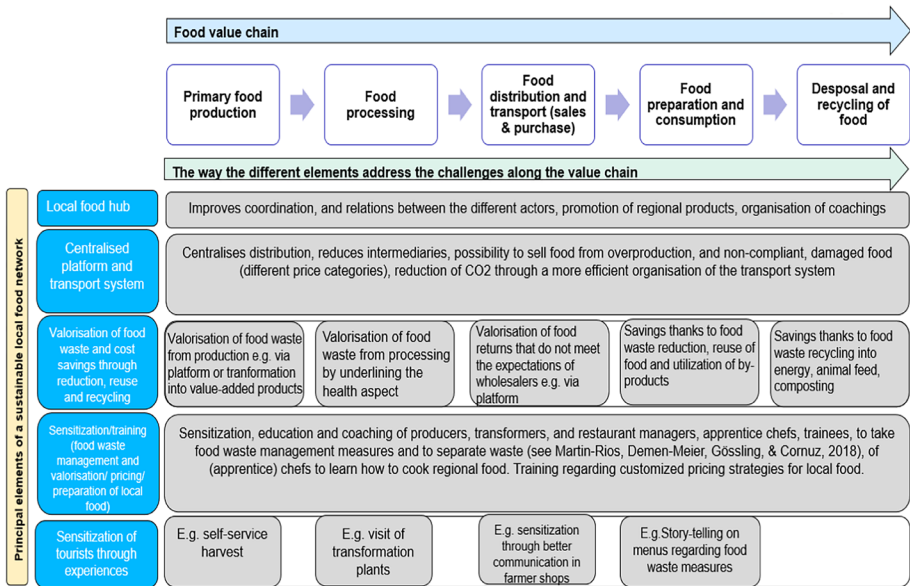


Fig. 2 Model of a sustainable and circular culinary system. Source: own elaboration

The processing stage holds great potential for valorization regarding pulp, fibers, and apricot pits, which are residues of the processing, especially of fruits. These residues often contain ingredients that are salubrious and could be transformed into cosmetics, health products, or products with high nutritional value, such as fruit bars or baby food. Restaurants and hotels can also benefit from cost savings through better food waste management by reducing food waste, re-using food, and utilizing and/or recycling food waste (see [36]). Examples to reduce food waste are better planning of purchases or doggy bags. To reuse food includes passing several stages of food preparation, an example to recycle food waste is to prepare a bouillon with peelings. In many regions, chefs have a lot of knowledge about such techniques that need to be transferred. Value creation is highest when different stakeholders, as well as the environment, benefit. One such example mentioned by an interviewee is the transformation of grape seeds into flour. This creates benefits not only for the winemaker, but also for the local baker who can sell a typical product. Pastries containing grape seed flour can then be served during visits to wine cellars. Moreover, grape seeds contain valuable anti-inflammatory substances that are salubrious. This is a very good example of creating benefits at different levels (economic, social, health, ecological) thanks to the valorization of a food waste product.

The model also underlines the importance of sensitization, training, and coaching sessions for producers and restaurant teams regarding the valorization and management of food waste including food conservation methods and separation of food waste. The latter guarantees a certain waste quality to improve the valorization of food waste at the end of the cycle. Moreover, apprentice cooks should be trained in preparing regional and seasonal food. To address the challenge of high prices for local food, the restaurant and hotel managers should learn about different pricing strategies and cost-saving potentials.

Often, consumers are not willing to buy non-compliant and damaged products. At this point, a sensitization campaign is necessary that would show how those products could

be used and why they are perfectly edible or even unique in the case of damaged fruits and vegetables. So this could even be a marketing argument. Raising awareness about the benefits of local food seems to be necessary, too. This can for example directly happen in the farm shop when tourists meet producers. The creation of experiences seems to be a good way to sensitize the population and tourists concerning food waste, e.g., through self-harvest offers, visiting a transformation plant or storytelling regarding food waste measures of restaurants and hotels. Self-harvesting helps reduce the number of fruits and vegetables that are left on trees and in fields. It is however important to bear in mind that such fruits and vegetables can also serve as fertilizer. Hence, it is necessary to consider the benefits at the different levels of sustainability and to take a decision based on these considerations.

Implementation of this model would generate economic, social, and environmental value. At the economic level, producers can sell their products for better prices due to a reduction of intermediaries, and restaurants and hotels can save money thanks to access to centralized platforms, fruits and vegetables of different price and quality categories, and better food waste management. By strengthening relations between the different actors along the value chain, trust and a common identity can be created. At the ecological/economic level, the different measures help reduce and especially valorize food waste.

These findings lead to the following propositions:

Hypothesis 1: Producers can generate more income and bigger sales volume by selling their products via a central platform, by reducing intermediaries, and by disposing of overproduction and non-compliant and damaged products.

Hypothesis 2: Restaurants/hotels can save money by buying fruits and vegetables of different price categories via the platform and by implementing food waste management measures.

Hypothesis 3: Transformers can generate added value thanks to the valorization of transformation waste, such as pulp, fibers, or pits.

Hypothesis 4: Through better waste management at the different stages of the value chain (distribution of fruits and vegetables stemming from overproduction via centralized platforms, valorization of transformation waste, better food management in restaurants and hotels), food waste can be reduced.

Hypothesis 5: Through the organization of events and the creation of a coordination hub, relations, trust, and a common feeling of identity between the different actors of the value chain can be strengthened.

Conclusion

As to the criticalities of the current culinary system in Valais, the findings underline that it (1) lacks relations between producers, transformers, and restaurants/hotels, and it lacks (2) a centralized distribution system and efficient transport. Moreover, the researchers identified (3) differences in price perception between producers and buyers, as well as (4) differences in the quality and quantity of food. Additionally, there is (5) a lack of sensitization concerning the benefits of regional and seasonal food among some restaurants and clients but also (6) a lack of knowledge regarding the preparation of regional food and food waste management among some restaurants and apprentice cooks. Finally, (7) a lack of promotion of regional food was identified.

The results are of particular interest for policy strategies focusing on the promotion of regional food networks. In terms of practical applications, the study suggests different solutions based on current literature and the potentialities identified in the case study region to transform current food systems into circular, re-localized food networks that help valorize local food in rural tourism regions (see Fig. 2). At the conceptual level, the model helps better understand the mechanisms, challenges, and possible solutions in the context of the implementation of a sustainable and circular culinary system.

One of the methodological limitations of this study is that consumers and tourists have not been interviewed. Moreover, the researchers were not able to do a complete holistic diagnosis, as Battistoni et al. [8] suggest including qualitative and quantitative methods and the analysis of the whole context. As the project was funded by national and regional authorities, which shows their advocacy for a sustainable and circular culinary system, the authors did not concentrate on the role of those authorities in the current study, who normally have considerable influence on the development of such a system, especially regarding financial support.

Future research will focus on testing the propositions formulated above by implementing the model of a sustainable and circular culinary system in the case study regions and in other regions. It is essential to measure its outcomes at the three levels of sustainability by combining qualitative and quantitative methods to verify if food waste could be reduced. It would also be interesting to include other regional products (meat, cheese, etc.). The implementation of such a system depends on the different actors' willingness to collaborate and the feasibility of some measures in the context of a rural region, where the critical mass to implement certain solutions, is often lacking.

Although the different challenges and potentialities have been identified in other studies, the originality of this paper lies in its holistic and systemic approach, as well as the practice-oriented model for a sustainable culinary system based on principles of CE and SD.

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Author Contribution The authors constructed the research design. They collected and analyzed the data and wrote the synthesis of the research and its results in this paper.

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Data Availability Anonymized data can be requested from the authors.

Declarations

Ethics Approval and Consent to Participate All participants agreed to take part in the research on their behavior, knowing the objectives and the reasons for the process.

Consent for Publication The paper does not contain any personally identifiable data.

Competing Interests The authors declare no competing interests.

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